

# Hybrid Lithium-ion Capacitor / Lithium-ion Battery System for Extended Performance

Completed Technology Project (2011 - 2012)



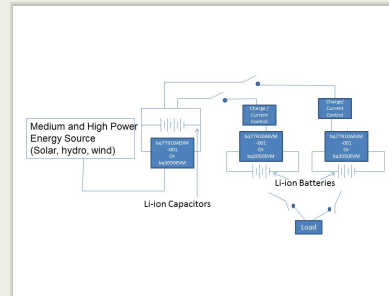
## Project Introduction

The proposed task will involve the design of a hybrid power system with lithium-ion (li-ion) capacitors (LICs), li-ion batteries and solar cells. The challenge in energy storage for long-term space missions is to obtain greater than 230 Wh/kg that equates to providing power for the EVA suit and surface systems for a minimum of eight hours. Although the current EMU li-ion battery provides power for 8 hours, it weighs about 6 kg and is only one of four battery systems providing power for various applications. The new advanced suit will include, apart from the existing power demands, an array of biological sensors and monitors and a high-tech video system with a mass limit on the battery of less than 5 kg. No battery-only system can currently provide this capability for a continuous 8 hour period, even with the advanced silicon-based anodes being studied in the battery industry today. Working on human-rated space technology requires higher safety goals which, we believe, this system will provide.

The work focused on testing the Li-ion supercapacitors to confirm their performance and safety. The li-ion supercaps were found to be safe under several off-nominal conditions such as overcharge, overdischarge into reversal, external short and simulated internal short. The li-ion supercaps were found to hold charge for the three month period tested and showed insignificant loss in capacity after that hold period. The li-ion supercaps were found to have the capability to accept charge quickly from a power supply. The testing to provide controlled current from the supercapacitors to the battery was not completed due to lack of personnel to carry out the testing. With the help of an intern this Fall, that work will be completed.

## Anticipated Benefits

The project will focus on building and testing a hybrid energy system which will consist of the LICs and li-ion batteries and solar arrays or an alternative power source to charge up the LICs. The goal is to obtain an optimized method that will fully utilize the li-ion capacitor and battery combination to obtain the maximum battery run time. The final phase will utilize the Innovation Design Center (IDC) to carry out the integrated test optimization after initial testing in the Energy Systems Test Area. A field demonstration will be carried out with the AES, as well as the Robotics hardware platforms.



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## Table of Contents

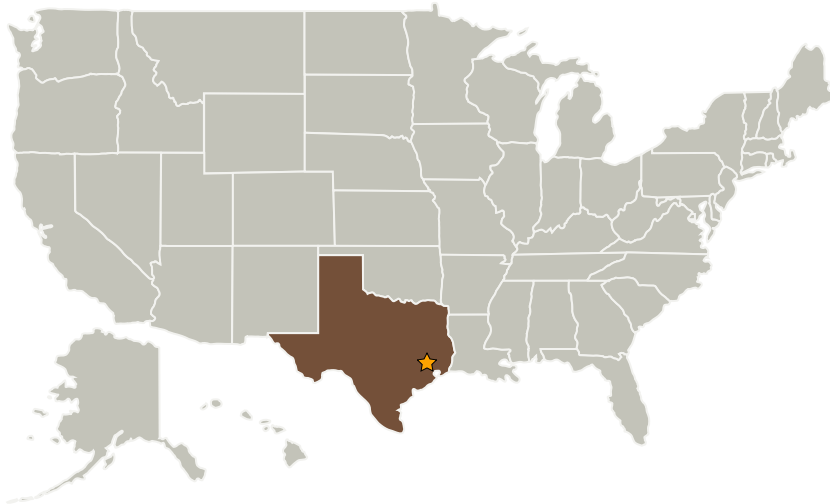
Project Introduction	1
Anticipated Benefits	1
Primary U.S. Work Locations and Key Partners	2
Organizational Responsibility	2
Project Management	2
Images	3
Links	3
Technology Maturity (TRL)	3
Technology Areas	3

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## Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★ Johnson Space Center(JSC)	Lead Organization	NASA Center	Houston, Texas
Jacobs Engineering Group, Inc.	Supporting Organization	Industry	Dallas, Texas

### Primary U.S. Work Locations

Texas

## Organizational Responsibility

### Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

### Lead Center / Facility:

Johnson Space Center (JSC)

### Responsible Program:

Center Innovation Fund: JSC CIF

## Project Management

### Program Director:

Michael R Lapointe

### Program Manager:

Carlos H Westhelle

### Project Manager:

Judith A Jeevarajan

### Principal Investigator:

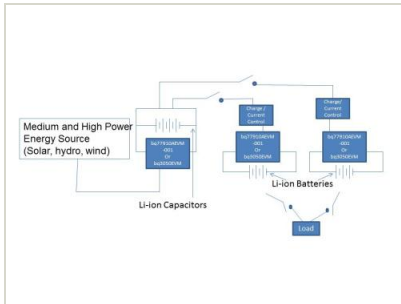
Judith A Jeevarajan

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## Images



**12146-1377275791311.jpg**

Project Image Hybrid Lithium-ion Capacitor / Lithium-ion Battery System for Extended Performance  
(<https://techport.nasa.gov/image/2254>)

## Links

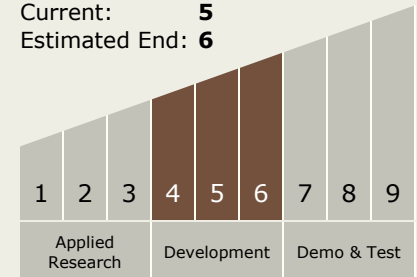
License Link 1  
(<http://Will not be requested>)

Patent Link 1  
(<http://Patent submission not accepted>)

NTR 1  
(<http://N/A>)

## Technology Maturity (TRL)

Start: **4**  
Current: **5**  
Estimated End: **6**



## Technology Areas

### Primary:

- TX03 Aerospace Power and Energy Storage
  - └ TX03.2 Energy Storage
    - └ TX03.2.1 Electrochemical: Batteries